

2005

Insect colonization of child-sized remains and delay of post mortem interval: an exploratory study in the behavioral analysis of pig carcasses via 24 hour high resolution video surveillance

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**INSECT COLONIZATION OF CHILD-SIZED REMAINS AND DELAY OF POST
MORTEM INTERVAL: AN EXPLORATORY STUDY IN THE BEHAVIORAL
ANALYSIS OF PIG CARCASSES VIA 24 HOUR HIGH RESOLUTION VIDEO
SURVEILLANCE**

A Thesis

**Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College**

**In partial fulfillment of the
requirements for the degree of
Master of Arts**

In

The Department of Geography and Anthropology

**By
Abigail L. Gremillion
B.A., Louisiana State University 2003
May 2005**

ACKNOWLEDGEMENTS

This research would not have been possible without the assistance of Dr. Wayne Lord, SSA, FBI, and Mr. Bob Morton, MS, SSA, FBI. I thank you both for working with me on this project and graciously allowing me to use it as my thesis research. My passion for fieldwork in this critical field of anthropology, entomology, and child abduction epidemiology would never have come to pass if it were not for your influence on my academic career. The insight of Dr. William Rodriguez, Armed Forces Medical Examiners Office, proved especially helpful for the direct application of this research in child abduction scenarios and insight into the forensic analysis of child abduction-homicide cases. Gunnery Sergeant Walter Hubler, US Marine Meteorological and Oceanographic Division, Quantico, Virginia graciously provided weather data for the duration of the experiment. His efforts on the meteorological side are extremely appreciated and will prove to be very valuable for this experiment and for future publications. Jay Grimes, Louisiana State University, provided valuable insight into the type of equipment that should be used for proper measurement of microenvironmental conditions.

The Critical Incidence Response Group of the FBI must be acknowledged for encouraging me during the duration of this experiment. Ms. Cynthia Lent, FBI, and Dr. Kristen Beyer, FBI, must be thanked for selecting me for an internship with the FBI's National Center for the Analysis of Violent Crime. Without their selection of me, none of this would have been possible. I would like to give special thanks to Ms. Lent for her tireless efforts in copying the surveillance video along with the interns who assisted her.

Dr. M. Lee Goff, Chaminade University, must be thanked for verifying my initial identifications of arthropod specimens collected during the duration of this study. Colonel Tom Tucker, National Center for Biomedical Research and Training (NCBRT), and Mr. Rick Matthews, NCBRT, must also be thanked for giving me the time I needed to complete my thesis as well as use of a conference room for my defense.

I thank my advisor, Ms. Mary H. Manhein, who was willing to speak with me about my interest in forensics when I was still in high school. Your willingness to mentor and advise me throughout my academic career has meant so much to me. I would also like to thank the other members of my committee from Louisiana State University: Dr. Chris Carlton, for teaching me everything he knows about flies and for patiently guiding me through my most frantic moments; Dr. Michael Leitner, for putting up with me and my statistics questions; and Dr. John Pine, who encouraged me and acted as my advocate. Dr. Wayne Lord served on my committee as my FBI representative. In addition, I would also like to thank the following faculty members from Louisiana State University for generously donating much of their time and effort in making this work useful and effective for use in anthropology, entomology, and for use in medico-legal contexts: Dr. Chris Austin, Ms. Victoria Bayless, Dr. Timothy Showalter, and Dr. Erin Watson. From the bottom of my heart, thank you.

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ABSTRACT

This research was designed to document the decompositional and behavioral patterns and activities of arthropods colonizing child-sized remains, as observed by field sampling and 24-hour, high resolution video surveillance. The purpose of this research was to test the relationship between delays in arthropod colonization of child-sized remains and climatic conditions.

Between March and June 2004, the remains of two child-sized pigs (approximately 11 kilograms) were deposited in an isolated wooded region in a suburban area of Virginia. The sites were secluded, approximately 83 yards from any dwellings. The pigs were placed on the surface: one was clothed, the other was unclothed. Wire cages were placed over them to prevent larger scavengers from consuming the specimens. Two high resolution video cameras were set up utilizing an infrared light source for night viewing. The cameras were set to record on a 24-hour basis. Taping was conducted every day throughout the period. Remains were also physically monitored every day, arthropods collected, observations noted, and direct temperature and humidity readings taken with a psychrometer at the experimental sites. Data for the macro-environment were collected from the U.S. Marine Corps Meteorology and Oceanographic Division, which provided hourly data on wind speed and direction, temperature, humidity, sky cover, and weather observations. Two replicates of the study were conducted. Tapes were reviewed to document the number of arthropods visiting the sites, as well as species and activity. Inter-rater reliability was performed to ensure species documentation was accurate.

Results of this study demonstrate the relationship between weather and delays in arthropod colonization. For both replicates, rainy, overcast weather conditions delayed colonization even though temperatures were above established thresholds of activity. This study also showed the effect of arthropods' diurnal predilections. Additionally, it further highlighted the interspecies and intraspecies competition among insects for viable food sources and demonstrated exclusion and succession. Vertebrate scavenging was a factor even though all the specimens were secured in wire cages, as vertebrates successfully removed specimens from the cages. Results of this research reinforce the need for careful review of all factors when considering post mortem interval estimations.

CHAPTER 1: INTRODUCTION

On a chilly winter's night, a father tucked his child into bed believing he would see her again in the morning. Every parent's worst nightmare happened; their child was missing from their bed. After diligent searching by police and civilian search groups the child's remains are recovered in a remote part of the city. A neighbor was arrested, tried, and sentenced for the abduction and murder of the child. During trial, the defense brought up entomological evidence indicating that the murder occurred later within the chronology of events presented by the prosecution. The entomological evidence indicated that the murder would have occurred at a period of time when the suspect was under intense police surveillance. Forensic entomologists were called by both the defense and the prosecution to testify to the effects of weather conditions as a delay in arthropod colonization.

Delays in arthropod colonization can severely affect the prediction of time of death by skewing the first oviposition of calliphorids, and, therefore, affecting the accuracy of estimating time since death of a victim. Anthropological implications from a delay of arthropod colonization of a homicide victim factor into decomposition rates. Delays can occur from extreme weather conditions; in the fictional scenario presented above, unseasonably cold temperatures occurred after the body was deposited off the side of the road in the rural part of the city. Temperatures not only affect ovipositioning of arthropods, but the rate of decomposition of human victims, which is especially true for children.

Decomposition rates vary throughout the US due to differences in temperature, climate, and the size of the victim (Mann et al. 1990:103-107).

In child abduction-homicide cases, the child is murdered within the first 24 hours of the abduction event in approximately 94% of cases (Boudreaux et al. 1999:539). Locating and identifying child remains through organized searches is relatively unsuccessful. Skeletal elements of children blend into the environment and are difficult to recognize. Typically, child remains are discovered by accident, recovered through offender information, or are not recovered at all. Delays in recovery of victims often provide animals with opportunities for scavenging. The ability to distinguish animal and taphonomic changes from antemortem injuries is often crucial to an accurate determination of cause of death (Morton and Lord 2003:3-4).

Entomologists generally agree that weather conditions affect the oviposition by flies; the dispute occurs with respect to how much temperature and weather conditions affect oviposition. Oviposition of calliphorids aids forensic entomologists in approximating how long arthropods have been aware of a body in the area, but it does not determine time of death. The reliability of larval infestation by blow flies is important forensically in establishing minimum time since death because, in most environments, an exposed body will almost certainly be colonized within hours under suitable weather conditions (Archer 2003:574). Fly activity has been observed to begin immediately following death in decomposition studies (Lord and Goff 1998: 428), but this is not always the case. Factors that may serve to delay this invasion include cloud cover, temperature,

and rainfall. Specifically, factors of temperature and rainfall may inhibit or completely stop adult fly activity. The determination of postmortem interval (PMI) is complicated even further when a child victim is involved; the greater-surface area to volume ratios allow decomposition to occur more rapidly than adults, making search efforts for the recovery of a missing child difficult, if not impossible (Morton and Lord 2003:3).

From 112 articles queried between 1980 and 2005 on the subjects of decomposition and children from the *Journal of Forensic Sciences*, none dealt with the specific decomposition rates of child-sized remains. Because of the unique decompositional situations presented by scenarios involving children, forensic anthropologists must address the issue due to the increasing rates of childhood murder. The rate of childhood murder increased between 1995 and 1998 by over 50% within the United States (Boudreaux et al. 1999:539). Based on the findings of existing studies that have employed child-sized decomposition models and on reports from actual cases, child-sized remains appear to be “returned-to-nature” more quickly than those of adults.

A variety of influences, including environmental, behavioral, and zoological factors, contribute to the rate of child taphonomy. In warm weather, total skeletonization has been observed to occur in as little as six days (Morton and Lord 2000:156). Child remains undergo decomposition processes in a shorter time interval than adult remains due to their smaller size and greater surface-to-volume ratios. There is less flesh for arthropods to consume, so the remains are reduced to skeletal elements more quickly.

Size is also a factor in scavenging by feral animals. In larger remains scavenging canids are forced to pull and tear at limbs and other extremities to remove them. Smaller size allows for easier disarticulation and removal of an entire corpse (Morton and Lord 2000:156). Little people leave behind little things, and special investigative insights and efforts are required to recognize and recover such evidence (Morton and Lord 2000:170). Forensic scientists must have adequate knowledge to estimate accurately how long a person has been dead if they are to contribute to the resolution of the legal issues involved when a human body is recovered. The most common way to obtain such information is to conduct controlled studies on deceased individuals of known age, sex, and case/manner of death rather than in laboratory settings (Mann et al. 1990:103).

This experiment documents the decompositional and behavioral patterns and activities of arthropods colonizing child-sized remains, as observed by field sampling and 24-hour, high resolution video surveillance.

CHAPTER 2: LITERATURE REVIEW

Determining post-mortem interval from entomological evidence has traditionally entailed two basic approaches. The first approach to PMI estimation requires analyses of the time period necessary for the insect species to develop to the growth stage encountered at the death scene. Calliphorid and sacrophagid larvae provide the most accurate entomological indicators of PMIs because of their consistent development cycles. For this type of PMI estimate, larvae are only useful while there is soft tissue present. A second entomological approach to PMI is used when remains are in the more advanced stages of decomposition. This requires analysis of insect community structure as it relates to expected successional patterns, forming a template for dating the remains. This approach is more difficult and less accurate than analyses of fly development (Lord et al. 1994:216) because it “works backwards” to estimate oviposition, and may not necessarily correlate with time/date of death (Shean et al. 1993:941). Both estimates of PMI are susceptible to delays regarding the time of death due to weather windows of opportunity, proximity to resting fly harborages, probable seasonal population levels of blowflies, and accessibility of the remains to insects. The final estimated minimal PMI often will be longer than the estimated faunal ages (Haskell et al. 2000:128).

Weather is a known variable that influences determination of PMI. Oviposition occurs when the weather conditions include temperatures between 15 and 27° Celsius, light winds, sunny days, and no other direct continuous exposure of the organic material to the sun; oviposition has not been observed

during strong wind, rainy periods, or during the night (Itrona et al. 1991:242). Reduced oviposition has been observed at a shaded pig during periods of light rain and drizzle, while little has been observed at the exposed pig. This difference is primarily the result of the exposed carrion being nearly consumed (Shean et al.1993:941). In addition to weather conditions, the temperature at the death scene has been shown to be a major factor in determining post-mortem interval. “[G]rowth depends on temperature because the biochemical reactions that are the ultimate basis for growth are themselves temperature-dependent. At this level, heat of reactions, enzyme thermal properties, and membrane permeabilities all contribute to the temperature requirements for growth”(Haskell et al. 2000:288).

Ambient air temperatures are the major factors influencing the rate of maggot development because of their dominant role during egg and early larval development (Haskell et al. 2000:128). Ambient air temperatures are extremely important in influencing carrion decomposition primarily through the activities of calliphorid larvae. “Air temperatures can vary significantly between areas as little as 300 meters apart, and temperatures tend to show more extreme maximum and minimum range at exposed locations than do areas that are more shaded. These differences in temperature patterns can have a profound effect upon the decomposition rate of a corpse”(Shean et al. 1993:948). Studies conducted by Morton and Lord indicate that “cooler temperatures inhibit invertebrate activity. [T]he cooler temperatures (-1.1 to 10 degrees Celsius) suppressed any ovipositioning by female blow flies” (2003:13). Temperatures below ten degrees

Celsius appeared to inhibit oviposition in sacrophageous flies, and the time needed for the eggs to hatch appeared to be strongly influenced by the nocturnal drop in temperature (Itrona et al. 1991:242). Davies and Radcliffe have shown that *Calliphora vomitora* (Robineau-Desvoidy) larvae can continue to develop down to four degrees Celsius (Anderson 1997:948-949). Itrona et al. observed that the higher the mean temperature, the faster the larval growth of sacrophageous flies if there was not an unusually wide day/night temperature gradient (1991: 242-243).

Anderson noted *Phormia regina* (Meigen) developing more rapidly at higher temperatures, taking almost twice as long to complete each stage of development and to complete the entire cycle at 16.1° Celsius than at 23.0°Celsius (2000: 826). Lord, et al., noted a dramatic decrease in larval development of *Hermetia illucens* (Linnaeus) between temperature gradients of 30° Celsius and 27.8°Celsius. Adult *Hermetia illucens* reportedly become active during morning hours when temperatures reach 25°Celsius and have been observed sunning themselves on exposed, sunlit surfaces as early as 8:30 AM. Mating occurs near breeding sites in full sun when temperatures reach 27°Celsius. Oviposition peaks during early to mid-afternoon (noon -5 PM), when temperatures range between 27.5 and 37.5°Celsius (Lord et al. 1994:216-218).

As PMI increases, the accuracy of its determination from successional data is likely to decrease because carcasses of advanced decompositional age tend to attract the same set of late-successional species for extended periods (Schoenly 1992:1507). The increase in post-mortem interval also indicates a

less accurate or wider-ranging post mortem interval (Anderson 2000:1510). In general, faunal succession in and under the corpse will follow a predictable pattern (Haskell et al. 2000:127). Archer found that arrival was most delayed in winter, followed by autumn, spring, and summer (2003:571). However, reoccurring taxa can make PMI estimation more difficult for the entomologist because known periods of visitation on non-human carcasses may be different from their periods of visitation on human remains at different sites (Schoenly 1992:1510).

Forensic entomologists must also consider the possibility of larval activity prior to death. Goff suggests that if a living victim with an insect infestation died, the estimate would have been made on the basis of the most mature larvae indicating the minimum postmortem interval (Goff et al. 1991:1605-1606), and would not accurately reflect the true post-mortem interval. There has been previous speculation that oviposition could occur during evening hours if artificial light was present, which would skew post mortem interval. It was found by Tessmer, Meek, and Wright that “necrophilous egg decomposition did occur prior to and following the nocturnal evaluation period, and no egg deposition occurred on any carcass during the nocturnal hours regardless of the intensity of the artificial lighting. This information lends support to the general hypothesis that, barring atypical situations and possible oviposition during crepuscular periods, necrophilous calliphorid flies do not actively search and oviposit on suitable carrion at night” (Tessmer et al. 1995 441-442).

With reference to child abduction-homicide cases, if there is a substantial amount of time involved in the PMI, time-of-death estimates will be less precise based on the access of invertebrates to the decedent. Prior research demonstrates that carcass size has a direct relation to fly population. During the decay stage, Diptera larvae are almost entirely responsible for the rapid removal of biomass (Hewadikram and Goff 1991:239). Because of the greater surface-area to volume ratios of children, decomposition by invertebrate activity will theoretically require fewer flies and less time for the remains to fully skeletonize. Invertebrate colonization and subsequent scavenging is weather dependent, and during certain times of the year, portions of the United States experience temperature patterns that inhibit invertebrate activity (Morton and Lord 2003:4). Delays in invertebrate colonization may be caused by precipitation, clothing, a covering on the victim, and faunal disruption of arthropod activity.

Difficulty of insect infestation is noted by Galloway, et al., stating that sarcophagids are greatly influenced by temperature and sunlight, and a succession of cloudy days prevents larviposition. At this time the carcass is often too dried to be accessible. In summer, calliphorid eggs must be laid in the shade to ensure viability of the young. In the winter, the warmth of the sun aided the development process. Decomposition rates during the winter were slowed since larvae were only seen to be active during the day. Diptera larvae were able to break down to skeletal elements in one fifth the time during the summer as compared to the winter rates of decomposition (Galloway et al. 1989:612). Delayed decomposition is also noted at higher latitudes because of cooler

temperatures, snowfall, freezing weather during winter months, and more rain throughout the year. These conditions tend to inhibit dehydration of the soft tissues and decrease insect activity (Galloway et al. 1989:613). Rates of decomposition were lengthened due to a prolongation of the bloat stage because of elevation level (Allaire 2005:282).

Mary Manhein states that for those anthropologists that work in the applied field of forensics, an estimate of time since death has become a routine element in the case profile. Rates of decay are valuable evidence for reconstructing past events and for determining time since death. In above-ground forensic cases, consultation with forensic entomologists often adds invaluable expertise in our determination of interval since death. The entomologist can usually pinpoint the time since death, and that assistance is especially helpful when the person has been dead for a short period of time, or, specifically, before all soft tissues has completely decomposed (Manhein 2000:471). Rodriguez and Bass conclude that there is a close relationship between rates of human decay for surface deposit burials and carrion insect activity (Rodriguez and Bass 1983:431). In Rodriguez and Bass' 1985 work on buried remains, they address decomposition of surface deposit and buried remains, citing that surface deposits generally decay faster than burials (836-837). In the surface deposit studies that Rodriguez and Bass conducted, they noticed that there were successional patterns of insects that were attracted to the corpse (1983:426-427). For cases recovered from rivers, it was found that there is a significant relationship between state of preservation and identification

status. The amount of decomposition in the remains affected the ability to assign positive identification to those remains (Basset and Manhein 1997: 6). The decomposition of human cadavers was found to be the most rapid during the spring and summer, and the slowest during the fall and winter when carrion insect populations were at their minimum (Rodriguez and Bass 1983:430). Many of the carrion insects that Rodriguez and Bass observed were found to be active only during particular parts of the year (1983:430). Examination of various skeletal cavities, particularly inside the cranial vault, may produce remains of early successional insects. Gentle probing or washing of these cavities will remove these earlier insect remains for examination and identification (Rodriguez and Bass 1983:431).

Although not a perfect substitute for human remains, pigs are an accepted comparative model. The decomposition process for pigs approximates decomposition for humans and takes place in similar time frames. The unique microenvironment created by the introduction of a pig carcass or a human body into an existing habitat results in the attraction of a variety of scavengers and insects. Creation of a temporary food source, shelter, nursery, and the production of decomposition by-products alter normal flora and faunal communities, and produce observable and detectable changes (Morton and Lord 2000:157).

This research seeks to document the anthropological and entomological implications of a delay in colonization of arthropods on child size remains, with specific emphasis on the delays in colonization of arthropods, weather

conditions, and decomposition rates of child victims. Even though there has been a rise in child murder, the actual event of a child abduction homicide is rare. A review of the literature on child abduction epidemiology is necessary.

The study of child abduction epidemiology involves the quantification of child abduction cases involving children who have been recovered alive, murdered children, and children who have not been recovered but a suspect has been identified and prosecuted for the crime. Specifically, child abduction epidemiology is the study of the developmental victimology of children. For this research, abduction is defined as the coerced, unauthorized, or otherwise illegal movement of a child for the purpose of a criminal act. Homicide cases originally reported as abductions were included, as investigative experience has demonstrated that deceased child victims found quickly after their disappearance or in close proximity to the disappearance site. These scenarios are frequently categorized as homicides rather than abductions (Boudreaux et al. 1999:540).

Offense motives examined in child abduction epidemiology literature have been classified into five main categories: 1) sex, requiring physical evidence of an act (requiring pathology or serology); 2) emotion-based, consisting of child abuse fatalities, false allegations of child abduction made by parents, revenge, retribution, and rage-based crimes; 3) profit, including drug, robbery, or extortion cases; 4) infant abduction, with the intent to keep the child; and 5) unknown motivation (Boudreaux et al. 1999:540). Offenders were generally male and Caucasian. Caucasian and African American offenders committed their abduction differently. African Americans tended to abduct children close to their

homes, whereas Caucasian offenders abducted children from a variety of locations. Motive for each race group differed; Caucasians tended to abduct for sex, whereas African Americans committed abduction for emotion-related motives. Caucasian offenders were often unrelated to their victims, whereas African Americans were often related to their victims (Boudreaux et al. 1999: 541).

Victim characteristics in the child abduction epidemiology study were primarily Caucasian (72%), then African American (17%), and other minorities (11%). Victim gender was disproportionately female (70%). Female victims were older than male victims abducted, and more than half of victims knew their offenders prior to the abduction. Neonates, children between birth and one month old, were kept by the abductor because of paternal desire. Abduction of neonates commonly occurred from hospitals or from the victim's home. Infants, ranging between one month and one year of age, were often victims of emotion based crimes or of infant abductions (Boudreaux 1999:546).

In the event of a child abduction homicide when a child's remains are not located immediately, a limited amount of literature on decomposition is available for law enforcement. The majority of American field studies have been conducted by Morton and Lord of the FBI's National Center for the Analysis of Violent Crime (Morton and Lord 2000, 2003). Melanie Archer, an Australian Zoologist at the University of Melbourne and the Department of Forensic Medicine, has published several studies on stillborn neonate pig carcasses and the effects of rainfall and temperature on decomposition rates. Studies such as

Archer's are valuable but do not properly mimic a child abduction homicide. As cited by Archer, preliminary data suggest that newborns decompose at a rate three to five times faster than that of adults, and the patterns of decomposition may be different than adults because of body size, bone composition, and smaller populations of endosymbiotic gut microbes present within the body (Archer 2004:36). Archer also states that there is a difference in the weight of pig carcasses and human neonates; human neonates weigh on average 3 kg and rapidly gain weight after birth. The stillborn piglet carcasses used in Archer's study were on average half the weight of a human neonate. Methodological differences are also seen between studies conducted by Archer and her American counterparts. Archer's studies are split between fieldwork and laboratory work. In addition, Archer kept her specimens frozen before placing them in the field, which can skew the time between deposit and first fly strike significantly. The following study is a fieldwork study to ensure that the results will accurately mimic a child abduction scenario.

Foraging behavior made a significant impact in this study and may play a role in unrecovered child abduction homicide victims. Hensley observed that the most important food sources found in grey fox scat in Virginia were arthropods (64.7%), and fruits (66%). The composition of each category was seasonal, and no definitive staples to the diet were identified. Arthropods and fruit did not make the most volume in grey fox diet; cottontail rabbits (*Sylvilagus spp.*) accounted for 30.6% of the volume while wood mice (*Peromyscus leucopus*) composed 12.2% of the scat. Evidence suggests that grey foxes are opportunist feeders

whose diets vary widely in different environments (Hensley 1978:63). Scavenging by a grey fox is likely in any type of homicide scenario, but is particularly relevant to a child abduction homicide because of the small size, small volume, and large surface area of a child. In addition to grey fox predation, black vultures (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) visited both sites for both experiments, feeding for hours at a time. Owre and Northington note that turkey vultures depend on their sense of smell for location of food and rarely feed on live prey (1961:205). Black vultures feed on live and dead prey, and have excellent eyesight. They often fly low over the overstory of a forest and close to human dwellings to prey upon dying or dead carrion (Robinson 1994:448).

Mating behavior of necrophageous flies and carrion beetles is a critical variable in this experiment. Adult female insects that breed in patchily-distributed resources are under strong selection to deposit offspring in locations that maximize larval survival and growth rates (Archer and Elgar 2003:165). Although flesh is nutritious for necrophageous flies, carcasses are risky environments because larvae have limited dispersal powers and are defenseless (Archer and Elgar 2003:165). Maggots are vulnerable to predation by vertebrate scavengers and are prone to parasitoid wasps preying on the egg and larval stages (Archer and Elgar 2003:165). To ensure survival, the eggs and larvae must remain in sheltered regions of the carcass; because of this, females initially prefer to deposit offspring in the mouth (personal observation; Archer and Elgar 2003:165), natural orifices, wounds on the body, or in body folds (Archer and Elgar 2003:166). Females may choose to select different oviposition sites

according to their suitability for offspring development rather than a fixed preference for a particular oviposition site, or the amount of time the carcass has been exposed to the elements (Archer and Elgar 2003:166, 171). Ovipositioning calliphorids can produce around 200 eggs per cycle, while larvipositioning sarcophagids usually produce around 30-50 live larvae per cycle. Large maggot populations may rapidly be established on carcasses (Archer and Elgar 2003:166). Six different categories of arthropods will be examined as they migrate and emigrate from the site. A complete list of arthropods collected at the sites is located in Appendix B. Vertebrate visitation and scavenging will also be noted.

CHAPTER 3: METHODS AND MATERIALS

This research was conducted in a suburban area of Virginia, in close proximity to the FBI Academy in Quantico, VA. Two domestic pig (*Sus scrofa*) carcasses were deposited in a wooded area, simulating surface deposit scenarios.

Pigs used in the current study were killed by a single shot to the skull with a .22 caliber gun. After death, each pig was bagged and sealed to prevent arthropod colonization. Three hours and two minutes elapsed between time of death and time of deposit at each site. Permission for euthanization for this experiment was cleared by Louisiana State University's Institutional Animal Care and Use Committee because my work on this project was considered the work of a "visiting scientist" (see Appendix A for documentation of authorizing communication). The pigs were already dead when they were acquired. The size of these pigs, 9 – 13.6 kilograms each, is representative of a two-to-three-year-old. Two-to-three-year-old children are normally abducted by someone close to the family who has access to the child, and are normally not killed by gunshots. Cases in which two to three year olds are killed by gunshots are usually accidents. The cause of death for two-to-three-year-old child abduction victims is usually strangulation or asphyxiation. Death by gunshot is the least invasive method available for the presently-constructed methodology of this study.

This experiment was conducted in the months of March and April of 2004. A second replicate experiment was conducted in May of 2004 to ensure

consistency of the results. One of the pigs was fully dressed in children's clothes and one was left undressed. Temperatures were taken using a psychrometer at each site and compared with daily weather data provided from the Marine Corps Meteorology and Oceanographic Division. In addition, weather factors such as precipitation and humidity were noted. Observations of the remains were conducted twice daily, and the remains were videotaped via infrared cameras on a twenty four hour basis to record invertebrate activity.

Arthropods were collected at each site to amass a representative community of what visited the sites over time. The arthropods were then keyed taxonomically, and checked by Dr. M. Lee Goff, Chaminade University. The verified arthropods were then noted in a migration-emigration chart for the duration of the experiments constructed for the sites. Data from both the surveillance video and the collected specimens were included in the migration-emigration chart.

This experiment used field observations and photographic documentation through remote sensing to detect the presence and absence of arthropods. The presence of arthropods increased the probability of arthropod offspring in the forms of eggs or larvae. Correlations of the averaged arthropod visitation per day were calculated with the variables of high temperature, low temperature, and averaged daily temperature. Analysis of Variance (ANOVA) of the clothed and unclothed pigs was calculated for the six arthropods this study focused on using SPSS. The data generated from this experiment provides a foundation for further

research into delays in postmortem interval and decomposition of child sized remains.

CHAPTER 4: RESULTS

The first round of this experiment began on March 8 and lasted until April 15, 2004. This replicate took the longest because of the extreme low temperatures and the presence of snow, rain, and mist with high percentages of relative humidity. Figure 1 is a graphic depiction of the maximum and minimum temperatures between March and May of 2004. Threshold temperatures at 15 and 30 degrees Celsius are marked within the Figure. The threshold is broken 11 times for the maximum temperature at the 15 degree threshold. The low temperature breaks the 15 degree threshold three times. The high temperature threshold of 32 degrees Celsius was broken seven times during the second replicate. This Figure demonstrates that the conditions were warm enough to promote oviposition by calliphorids during the two experiments.

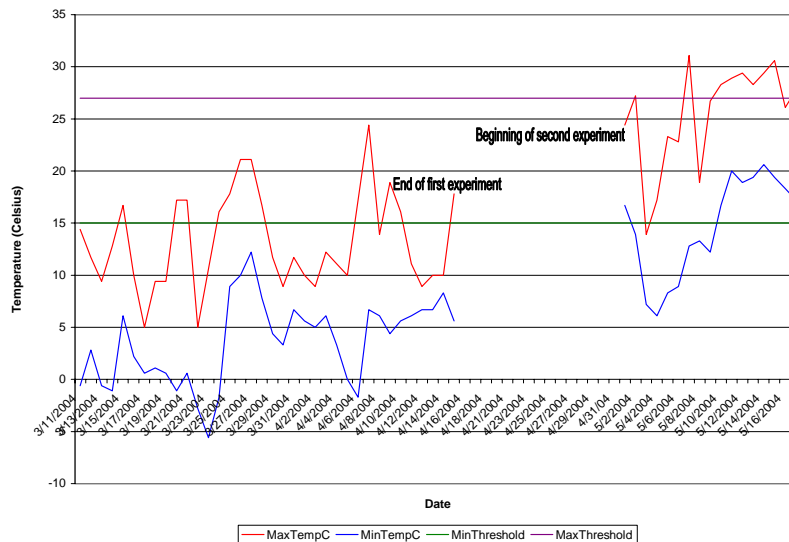


Figure1. Average Minimum and Maximum Temperatures Between March and May 2004 with Marked Threshold for Insect Activity

Table 1 is a migration-emigration chart of arthropods that attended the sites derived from collection at the site by netting and hand-collection and video surveillance. The colored blocks symbolize activity by each indicated arthropod as a result of the specimen collection or from identification from the surveillance video. White blocks indicate an absence of the arthropod at the site. The chart is intended to be read across for each day, or vertically to understand when each arthropod would arrive and leave the site. The categories on the chart, “blue”, “green”, “black”, “silphid”, “staphylinid”, and “hister” indicate which arthropods were being observed. “Blue” indicates the presence of *Calliphora vomitoria* (Linnaeus). “Green” represents *Phaenicia coeruleiviridis* (Macquart). “Black” represents *Phormia regina* (Meigen). “Silphid”, “Staphylinid” and “Hister” are representative of the families Silphidae, Staphylinidae, and Histeridae.

Figures 2 and 3 depict the averaged dipteran and coleopteran visitations of the nude and clothed sites for both experiments. The end of the first experiment and the beginning of the second experiment has been indicated within each of the figures. If these figures are compared against Figure 1, the increases in beetle and fly activity are also concurrent with temperatures observed in the experiment.

**Table 1. Migration-Emigration of Arthropods at Sites Derived from
Arthropod Collection & Surveillance, March – May 2004**

Month	Date	Blue	Green	Black	Silphid	Staphylinid	Hister
March	10						
March	11						
March	12						
March	13						
March	14						
March	15						
March	16						
March	17						
March	18						
March	19						
March	20						
March	21						
March	23						
March	24						
March	25						
March	26						
March	27						
March	28						
March	29						
March	30						
March	31						
April	1						
April	2						
April	3						
April	6						
April	7						
April	8						
April	9						
April	10						
April	11						
April	12						
April	13						
May	3						
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May	7						
May	8						
May	9						
May	10						
May	11						
May	12						
May	13						

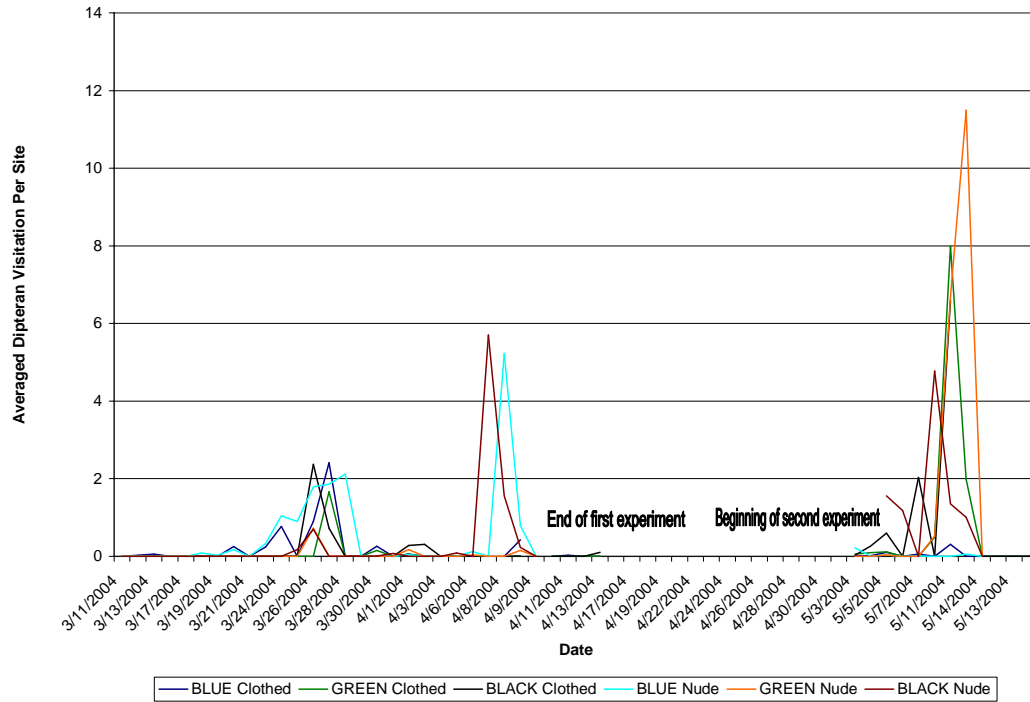


Figure 2. Average Dipteran Visitation at Clothed and Unclothed Site Between March and May, 2004.

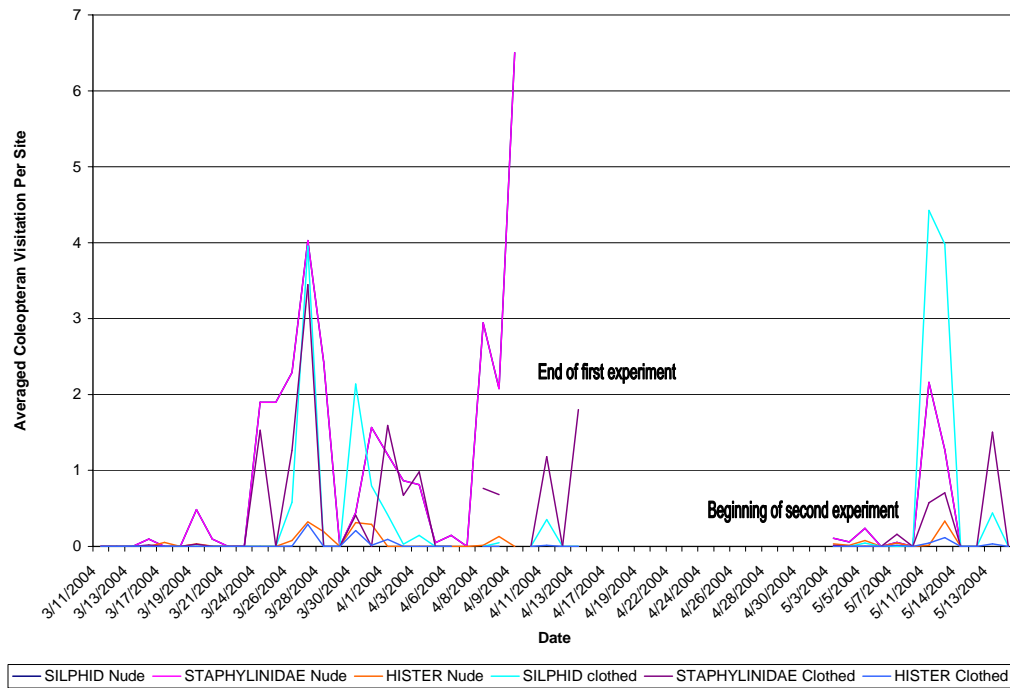


Figure 3. Average Coleoptera Visitation At Clothed and Unclothed Sites Between March and May 2004

Decomposition was significantly slowed because of the delay of arthropods colonizing the carcasses, caused by temperature, weather condition, and the presence of clothing. The unclothed pig featured in Figure 4 lay undisturbed thirty-one days of the first replicate. The scarcity of flies in the picture indicates that temperatures were cold enough to deter oviposition and preserve the pig in a frozen-fresh state.



Figure 4. Thirty-Second Day, First Study, Unclothed, 4:30 PM April 6, 2004

The clothed pig in Figure 5 was photographed on the thirty fourth day of the study. The extreme low temperatures have kept arthropods away from the clothed pig, leaving it relatively untouched with respect to consumption by maggot masses. Evidence of vultures feeding on the carcass can be seen in the figure; the mandible has been peeled away, the leaf-litter surrounding the cage has been moved; distinct patterns in the dirt have been made by the wings of the vultures as they moved around the carcass to feed. Tracks from the vultures can also be seen around the head, and there is little arthropod activity seen on the carcass.



Figure 5. Thirty-Fourth Day, First Study, Clothed, 4:30 PM April 8, 2004.

Figure 6 shows the unclothed pig on the thirty-fourth day; the difference is that the unclothed pig has been fed on more heavily than the clothed pig. In this experiment, clothing acted as a barrier for feeding sites and for decomposition. The legs are disarticulated from the carcass, and a feeding site made by vultures on the head of the unclothed is visible. The uncovered surface increased the number of feeding sites available for vultures. Tracks left by the wings and feet of the vultures are seen in the dirt as they fed on the unclothed pig, and are readily visible in Figure 6.



Figure 6. Thirty-Fourth Day, First Study, Unclothed, 4:30 PM, April 8, 2004.

Figure 7 of the clothed pig was photographed on day 39 of the study. The pig has been partially pulled from its cage by vultures; multiple feeding sites on the eyes and into its torso are visible. The vultures broke through the diaper that the pig was wearing, and ripped out part of the gastrointestinal tract. The stomach and its contents are readily visible. Fragments of the diaper are also seen around the gastrointestinal tract on the ground. It can be noted in the figure that it had rained previously because the leaf litter and the dirt are dark and wet in appearance. Rainy weather plays a large factor in the delay of carrion flies to feed and oviposit on these newly-exposed sites on the clothed pig as seen in Figure 7.



Figure 7. Thirty-Ninth Day, First Study, Unclothed, 8:30 AM April 13, 2004.

By the afternoon of day 39 the majority of the soft tissues were gone. The gastrointestinal tract seen in Figure 8 has been consumed by vultures. The vultures have also pulled the majority of the carcass out of the cage. The leaf litter underneath the pig is darkly stained from the purge that made contact with the ground. Purge only began when temperatures were warm enough for

significant fly and beetle activity to occur. Skeletal elements, clothing, and some flesh are all that remain of the pig in Figure 8.



Figure 8. Thirty-Ninth Day, First Study, Clothed, 4:30 PM, April 13, 2004.

Figures 9 – 11 were photographed during the second replicate of the study. Figure 9 was taken on day 2 of the second replicate. The clothes are wet and dirty from a previous rain. There are no arthropods on this pig or evidence of leaf litter disruption or vertebrate predation.



Figure 9. Second Day, Second Study, Clothed, 9 AM, May 4, 2004

Figure 10 was photographed on day 2 of the second replicate. The carcass is still very fresh and is not attracting any flies.



Figure 10. Second Day, Second Study, Unclothed, 9 AM, May 4, 2004

Figure 11 shows the nude pig one week into the second replicate of the experiment. There are established maggot masses on the head and neck areas of the carcass. Significant bloating has occurred because of warmer temperatures. Flies can be seen resting on the corpse in Figure 11.



Figure 11. Ninth Day, Second Study, Unclothed, 9 AM, May 11, 2004

Figure 12, photographed on day 19 of the second study, shows the recovery of the clothed remains after the maggot migration. Vulture tracks can be seen around the cage where the vultures had been feeding. The white, waxy film on the dirt and leaves is the trail that the maggots took as they migrated away from the carcass. The body stain can be seen on the leaves where the pig

was laying. Skeletal elements were located within and outside the cage. Figure 12 emphasizes how easily skeletal elements blend into the environment.



Figure 12. Nineteenth Day, Second Study, Clothed, 9 AM, Recovery

The most significant factor for the delay of postmortem interval in the first replicate was temperature. Weather conditions also contributed to the delay of arthropod colonization.

A Pearson's correlation with two tailed significance at the .01 level and ANOVA were calculated for this experiment. "A Pearson's correlation coefficient is a quantitative assessment of the strength of relationship between the x and y values in a set of (x,y) pairs" (Devore and Peck 2005:186). Correlations were calculated between the averaged frequencies of arthropod visitation against variables such as minimum temperature, maximum temperature, and averaged temperature, respectively. For the correlations, a two tailed significance test was run for all arthropod data against the variables of maximum temperature, minimum temperature, and average temperature.

Table 2. Averaged visitation of arthropods at clothed site correlated with of minimum, maximum, and averaged temperature (C) for both first and second experiments.

Correlations from Clothed Remains			
Arthropod	Average Temperature Correlation	Minimum Temperature Correlation	Maximum Temperature Correlation
Blue Bottle	.009	*-.286	-.147
Green Bottle	-.053	.031	-.129
Black Blowfly	-.119	-.064	-.159
Silphids	-.009	.033	-.049
Staphylinids	-.075	-.177	.036
Histers	.057	.020	.085
* indicates significance at the .1 level as noted in SPSS			

Blue bottle flies were found to be significant at the .1 level for the clothed remains. For all other arthropods of interest in this study, there was no statistically significant correlation between the arthropods found at the clothed site with average, minimum, or maximum temperature.

Table 3. Averaged visitation of arthropods at unclothed site with correlations of minimum, maximum, and averaged temperature (C) for both first and second experiments.

Correlations from Unclothed Remains			
Arthropod	Average Temperature Correlation	Minimum Temperature Correlation	Maximum Temperature Correlation
Blue Bottle	-.142	-.166	-.088
Green Bottle	-.016	.152	-.167
Black Blowfly	-.064	.103	-.203
Silphids	-.118	-.098	-.110
Staphylinids	-.118	-.098	-.110
Histers	.239	.193	.229

For all arthropods of interest in this study, there was no correlation between the arthropods found at the unclothed site with average, minimum, or maximum temperature. This is expected because the majority of the data occurs during cold weather, when arthropods are not observed.

ANOVAs were calculated on the frequency of each type of arthropod combining both replicates for the clothed and nude sites. According to the ANOVA results for averaged visitation of arthropods at clothed and unclothed sites, there is no statistical difference between the number of arthropods at the clothed remains between the two experiments. The ANOVA results for the unclothed remains were found to be significant at the .01 level. This means there are statistically significant differences between the visitation frequency between at least two of the six arthropods.

Table 4. ANOVA calculations averaged visitation of arthropods at clothed & unclothed site

(F) of ANOVA and Significance	
Clothed Remains	Unclothed Remains
(F)1.537, Sig. .179	***(F) 3.377, Sig. .006

A post-hoc test (Scheffe test) revealed that there is significance between the activities of the beetles in this study. Silphid activity levels were found to be different from that of histars at the .05 level. Likewise, staphylinid activity levels were found to be different from histars at the .05 level. There are several explanations for these findings. All three types of beetles are attracted to carrion, but each has different behaviors when associated with the carrion. Silphids and histars can typically be found in the leaf litter or running around or on top of the

carrion. Histers are usually found in the leaf litter or directly underneath the carrion. When disturbed, histers will curl up into a ball and stay still, whereas silphids and staphylinids will typically try to run away or bite the disturbing vertebrate. A secondary factor may lie with the temperature threshold activity levels of each beetle.

Vulture predation on the remains accounted for more than half of all the vertebrate activity in this study. Both black vultures and turkey vultures were recorded by the infrared cameras and observed during the daily checks of the sites. Vultures began to frequent the carcasses on April 8, 2004, on the clothed carcass. The vultures continued to feed on the carcass daily until April 13, when it was consumed. Feeding on the unclothed pig began on March 31 and continued through April 8. For the replicate, black vultures were observed at the unclothed site on May 10 and at the clothed site on May 11.

Other animals that visited the carcasses and attempted feeding were a raccoon and a Virginia opossum. On the 8th of April, a raccoon was seen attempting to feed at the unclothed site.

CHAPTER 5: DISCUSSION

In order to examine the delays in colonization of arthropods and its relationship to decomposition, the variables of temperature, precipitation, and scavenging were reviewed.

Temperature

Cold temperatures played a critical role in the delay of arthropod colonization. The lowest temperature recorded for the experiment was -5.6 degrees C. The lowest temperatures recorded for days with a significant averaged dipteran activity of 1 in this study was a low temperature of -1.7 degrees C, and a high temperature of 16.1 degrees C. Minimum threshold temperatures for dipteran activity were not broken until May 1 2004, and then dropped below the threshold. The minimum temperatures did not break the established threshold temperatures again until May 10, 2004. Average temperatures broke the 15°C threshold established by Itrona et al. (1991:242) on March 29 and on May 13. According to the averaged counts of arthropod visitation per day, maximum temperatures that crossed the activity threshold saw coleopteran activity, but very little dipteran activity on March 15, 16, 20, 21, and 22. Beetle activity occurred from March 15 – 17, and on March 19. There was a significant increase in fly and beetle activity at both sites from March 24 through 29 because temperatures were warm enough for ovipositioning to occur. The increase in beetle activity at both sites indicates that the beetles were predating on eggs that flies were laying. The significant amount of beetle predation at both sites probably caused a longer delay of PMI because the consumption of eggs or

first instar larvae would prevent the consumption of the corpse by growing maggots. The increase in beetle activity lasted from March 23 through April 4, when the averaged visitation rate decreased to less than 1. Beetle activity increased again from the fourth through the tenth of April. After this time period, the only significant increase in beetle activity came from histars between April 10 and 13.

There was a very interesting graphical relationship between temperature, presence of flies, and presence of beetles. There is a significant number of flies at the sites from May 3 through May 7. The average of fly visitations increases dramatically through May 14. Interestingly, the beetles do not really begin to arrive at the sites in significant numbers until May 11. Significant numbers of beetle visitations began on May 11 through May 14, but the averaged fly visitation overtook the beetle visitation average. This would explain the successful colonization of maggot masses for the second replicate compared to the first.

With respect to the correlation coefficients listed in Table 2, blue bottle flies were found to be significant at the .1 level for the clothed remains. This is probably because blue bottle flies are more active in colder temperatures, and the clothing on the pig would keep the overall temperature of the pig warmer than that of the nude, making it a more suitable place to oviposit. Only seven of the eighteen coefficients were positive in this study for the combined experimental data. This is because the flies and the majority of beetles require warmer

temperatures to become more active within a microenvironment created by a carcass.

Positive correlation coefficients in this study indicate that as the temperature increases, the amount of activity will increase. Negative correlation coefficients indicate that as the temperature drops, activity decreases. The negative association between minimum temperature and the activity of blue bottle flies demonstrates statistically that, out of all the flies examined in this study, blue bottle flies are more likely to be active in colder temperatures. For all other arthropods of interest in this study, there was no statistically significant correlation between the arthropods found at the clothed site with average, minimum, or maximum temperature. After examining correlations for the unclothed remains, there was no correlation between the arthropods found at the unclothed site with average, minimum, or maximum temperature. This is expected because the majority of the data occurs during cold weather, when arthropods are not observed.

ANOVAs were calculated on the frequency of each type of arthropod combining both replicates for the clothed and nude sites. ANOVA is defined as, “a comparison of a k population or treatment meaning that all observed groups within a population will be compared against one another to determine if the population is homogeneous or there are at least two observed groups within the population “(Devore and Peck 2005:666). According to the ANOVA results for averaged visitation of arthropods at clothed and unclothed sites, there is no statistical difference between the number of arthropods at the clothed remains

between the two experiments. This finding is explainable because the presence of clothing acts as a deterrent in both replicates for arthropod consumption by limiting the access to the corpse. The ANOVA results for the unclothed remains were found to be significant at the .01 level. This means there are statistically significant differences between the visitation frequency between at least two of the six arthropods.

A post-hoc test (Scheffe test) revealed that there is significance between the activities of the beetles in this study. Silphid activity levels were found to be different from that of histars at the .05 level. Likewise, staphylinid activity levels were found to be different from histars at the .05 level. There are several explanations for these findings. All three types of beetles are attracted to carrion, but each has different behaviors when associated with the carrion. Silphids and histars can typically be found in the leaf litter or running around or on top of the carrion. Histars are usually found in the leaf litter or directly underneath the carrion. When disturbed, histars will curl up into a ball and stay still, whereas silphids and staphylinids will typically try to run away or bite the disturbing vertebrate. A secondary factor may lie with the temperature threshold activity levels of each beetle.

Precipitation

The type of precipitation that occurred at each site affected delay of PMI. When flies successfully colonize a carcass, independent of clothing, beetles will migrate to feed on maggot masses. When there is a delay in the colonization of the carcass by flies caused by weather conditions, beetles will come to the

corpse for shelter, limited feeding, and for rearing young. Delays of PMI that occurred in this experiment include cold temperatures, rain, mist, and high percentages of relative humidity according to field notes and meteorological data provided by the United States Marine Corps. Beetles will come to a corpse in these types of conditions because it is a large food source. On days that were categorized as clear to partly cloudy and maximum temperatures fell below the threshold, no arthropod activity occurred at the sites. Arthropod activity is dependent on primarily temperature, and secondarily weather condition.

The weather conditions experienced during the second replicate posed an interesting scenario because it was primarily sunny, with some rain experienced during the first forty-eight hours of the study. Flies still frequented the carcass during the first seventy-two hours of the experiment, but not enough to establish whole number averaged visitations. The only exception to this was an average of two black blow flies to the carcasses on May 5. Rainy and cloudy conditions did not prevent some fly visitation on May 4, but it was not enough to average as one fly visitation for the day to the site. The visitation of flies on May 4 was more than likely because the high temperature was 17.2°C.

Scavenging

Vertebrate scavenging was also a factor in the decomposition of child sized remains. The infrared cameras recorded the scavengers who frequented the carcasses, and the intervals at which they frequented the carcasses.

The majority of vultures who fed at the site were black vultures. Movement of the vultures during feeding is usually in a clockwise manner; only once was the

feeding observed to move counterclockwise. The vultures maintain a pecking order when feeding on the carrion. The alpha bird selects a feeding site and begins to feed. The alpha will move clockwise for the next bird to feed at the chosen site by the alpha. All of the birds will feed at the pre-determined site on the carrion until the alpha chooses another site on the carcass to feed. At times, the alpha will feed in tandem with another bird in the flock, which can range from three to over twenty birds (personal observation from field notes). Usually, the feeding is on sites that are directly across from one another, and the clockwise turn of the vultures continues until feeding has stopped. When a bird is finished eating, it flies into the trees and watches for other vertebrates that may try to come to the carrion. This pattern continues until all of the birds have fed, or a larger vertebrate disturbs them.

Turkey vulture feeding patterns are similar to the patterns seen in black vultures. Turkey vultures were observed to fly in smaller flocks. On surveillance video, turkey vultures were seen hopping on top of the cage to reach the other side of the carrion. While vultures mangled the carcasses by sticking their heads through the cages, red foxes were responsible for completely pulling the carcasses out of their cages and removing them. Foxes attended the clothed carcass on April 12. On this visitation, the fox managed to pull the majority of the carcass out of the cage. Later that day the vultures fed on what was exposed by the fox. The foxes came back on May 13 during the second experiment and pulled the carcass out of the cage. I was able to identify the red fox because there was enough daylight to determine the color of his coat from the infrared

surveillance video. For the nude carcass, red foxes were seen on April 8 and May 11. On the April 8 visitation, two or more red foxes were seen feeding at the site from 4:18 to 5:00 AM. On May 11, a fox pulled the carcass out from the cage. The unclothed pig was not found on the May 12 checks. Other animals that were observed at the site were raccoons, opossums and foxes.

CHAPTER 6: CONCLUSION

Decomposition was slowed because of the delay of arthropods colonizing the carcasses, caused by temperature, weather condition, and the presence of clothing. Cold temperatures played a critical role in the delay of arthropod colonization. Pearson's correlation coefficients were not significant for almost all of the six groups of arthropods examined in the experiments with respect to minimum, maximum, and average temperatures. ANOVA results for the unclothed remains were found to be significant at the .01 level. This means there are statistically significant differences between the visitation frequency between at least two of the six arthropods. A post-hoc test (Scheffe test) revealed that there is significance between the silphid and histers, and staphylinid hister beetles at the .05 level.

There are definite seasonal migration and emigration times for specific blow flies that are of forensic importance. Vertebrates play a significant part of the taphonomic processes involved in a child abduction homicide scenario by exposing more surface area for maggots to consume, and making the carcass more attractive for opportunist vertebrates to feed upon, move, or conceal the remains all together.

Future research should entail several methods of collecting specimens to build a robust reference collection for all insects that may be associated with a child-abduction homicide scenario. Pitfall traps, pan traps, and fly traps, in addition to netting and capturing beetles by hand should be used. When the

remains have been fully skeletonized, the dirt beneath where the carcasses lay should be sifted with a sifter, and funneled by Malaise funnels to allow for maximum collection of arthropods. GPS positioning should be taken at deposit and at recovery of the remains to track how far skeletal elements have been removed from the site. Larger, more robust cages should be built; cages should either be doubled in thickness of the current type of wire used, or should use a heavier wire to prevent vertebrate predation. Observations can be made as little as one time per day, but the times should be random so that all opportunities to collect the largest diversity of insects is possible. Also, the number of replicates should be extended from two to at least four when a delay in post-mortem interval is expected. The times of year for the decomposition studies should also be alternated between the four seasons, to observe how long delays in postmortem interval can occur within each season in the United States. A series of control decomposition scenarios should be conducted as a means of comparison against the delay of postmortem interval scenarios to determine how significant the delays are within the context of the decomposition rates of children. The control pigs can also be used, in addition to the delay of PMI, to calculate a rate of decomposition per day for child sized remains. The experiments should be conducted in the same area as the experiments presented in this thesis to keep results consistent for weather conditions and for arthropod reference.

Substantial work has been conducted on decomposition rates of adults and entomological implications of decomposition in adults, but little on child

remains. Future research should simulate children and carefully track decomposition and delays in colonization, and have a documented account of a delay in colonization of arthropods and subsequently a delay in decomposition of child-size remains.

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APPENDIX A

COMMUNICATION BETWEEN MARY MANHEIN AND DAWN BEST-DESJARDINS CONCERNING LSU IACUC.

From: "Dawn Best-Desjardins" <dbest@vetmed.lsu.edu> on 03/26/2004 10:47 AM

Sent by: "Dawn Best-Desjardins" <dbest@vetmed.lsu.edu>

Dear Abbie:

Good news! Please see Dawn's reply below in answer to my inquiry about your proposed thesis topic. As noted, since you are considered a "visiting scientist" at the FBI, no approval is necessary for our university. Well, first step taken care of. Be sure to keep a copy of this e-mail for the future.

Work on your proposal and get it to me, and, as your benefactors up there noted, be sure to address the issue of how what you are doing is clearly related to anthropology...specifically forensic anthropology in this case. Good luck. Talk to you soon. Mary

To: "'Mary H Manhein'" <gaman@lsu.edu>
Cc:

Subject: RE: Master's thesis - Quantico

The animal work was performed under the auspices of the FBI. Abbie could be considered a "visiting scientist". Therefore, she doesn't need to do anything as far as the LSU IACUC is concerned.

Dawn

-----Original Message-----

<mailto:gaman@lsu.edu>

Sent: Thursday, March 25, 2004 4:53 PM

To: dbest@vetmed.lsu.edu

Subject: Master's thesis - Quantico

Dear Dawn:

semester in our MA program as an intern with the FBI. She went to the FBI for this semester to work on a profiling project but had the opportunity to participate in a study involving the decomposition rates of decomposing bodies, using pigs as models. She would like to use her work with the FBI as her thesis topic. Because she has informed me today that she has done all of the research background, leg work, etc. for this project with the FBI, they have agreed that she could use this for her master's thesis. I have no problem with this in terms of the project being used for her thesis, but my question to you is how this fits into the IACUC rules and regulations for animal subjects. Would she still need to apply, though the project is almost over (she did not know when she went up there that this project even existed; additionally, the FBI, of course, has a protocol for such projects)?

I told her that I would first have to run this past you and see if there are rules on such a situation, even though the deed has already been done. I also told Abbie that she should correspond with you with regard to this, but I wanted to ask you about it first.

When you have a minute, could you e-mail me on this and let's figure out where to go from here. Thanks so much, Dawn. Mary Manhein

APPENDIX B

LIST OF IDENTIFIED SPECIMENS

Silphidae

Necrophila americana (Linnaeus)
Nicrophorus orbicollis (Say)
Heterosilpha ramosa (Say)
Oiceoptoma noveboracense (Forster)

Geotrupidae

Geotrupes splendidus (Fabricius)

Histeridae

Margarinotus hudsonicus (Casey)
Euspilotus assimilis (Paykull)

Staphylinidae

Creophilus maxillosus (Linnaeus)
Staphylinidae: *Platydracus* spp.

Calliphoridae

Phormia regina (Meigen)
Phaenicia coerulescens (Macquart)
Calliphora vomitoria (Linnaeus)

Fanniidae

Fannia canicularis (Linnaeus)

Muscidae

Hydrotaea leucostoma (Wiedemann)
Hydrotaea dentipes (Fabricius)

Rhagionidae

Rhagis spp.

Larvae

Calliphoridae: *Phormia regina* (Meigen)
Muscidae: *Hydrotaea dentipes* (Fabricius)
Piophilidae: *Prochyliza xanthostoma* (Walker)
Muscidae: *Hydrotaea* spp.
Diptera: Calliphoridae

VITA

Abbie Gremillion graduated with a dual degree in biological anthropology and sociology, concentrating in criminology from Louisiana State University in May of 2003. After entering the graduate program in anthropology at LSU, she participated in an internship in the spring of 2004 at the FBI's National Center for the Analysis of Violent Crime (NCAVC) at Quantico, VA. Since the completion of her internship in late May of 2004, she has continued work on her assigned project with the NCAVC for her thesis research. She currently works for the Department of Homeland Security's National Center for Biomedical Research and Training on projects involving forensics and weapons of mass destruction and mass casualty events. Abbie wishes to continue her research on the decomposition rates of children in cooperation with the FBI upon entering a doctoral program in anthropology, with emphases in forensics and entomology. After completion of her doctorate, she wishes to enter FBI agent class in order to apply her first-hand knowledge of child abduction scenarios and other forms of violent and non-violent crime. She will be graduating in May of 2005 with a master of arts in anthropology and a minor emphasis in entomology.